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# IOT and Smart Cities

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**Abstract:** Smart City concepts enhance the equality, interconnection and performance of various urban services with the use of information and communication technologies (ICT). Smart City concepts uses Internet of Things (IoT) and cloud-based services. These services enable real-world users to use interfaces like smart phones, sensors and RFIDs. Wireless sensor networks play an important role in Smart City infrastructures. These sensors are used in developing smart cities. A smart city makes the quality of life modern, healthy, and safe. Some IoT applications are discussed in this paper that are required to develop a smart city.

**Keywords:** sensors, clouds, Internet of Things, smart city, ICT.

## I. INTRODUCTION

IoT (Internet of Things) is an enhancing technology that helps to interconnect all physical worlds using the internet with the help of devices like mobile, sensors, and actuators. These IoT devices collect data for which is used for analysis purposes in many **industries** and applications. IoT is used widely for creating smart cities, smart agriculture, improving business productivity and daily operations of many industries.

A smart city is large-scale and complex system which is dynamic in nature. Smart city concept makes life in cities more organized and efficient and uses wireless connectivity. Cloud is a new technique that is used to store data on the remote server and these servers are accessed through the internet.

Using this cloud technology today, we can access the data from anywhere with the help of the internet. Sensors are sensing devices that convert physical parameters like temperature, pressure etc into signals [3]. These are in the form of electrical signals and therefore it is easy to measure them.

Integration of sensors with cloud technology offers multiple applications but it makes the system a little bit complex [1] [3]. In sensor cloud integration, sensors sense the data and transmit it to the cloud.

There are multiple ways of transmission in IoT like Sensors to Cloud, Sensors to Mobile network to Cloud, Sensors to Wi-Fi, router to cloud etc. [3].

We use different machines in daily life such as fridges, windows, washing machines which could be easily accessed and managed through the internet via internet-based protocols. These protocols are IPV6, UDP/TCP, and HTTP.

## II. SMART CITY

Population is the main problem in cities. So efficient management of resources is required to fulfil the needs of citizens. So, we need to implement smart solutions. Smart cities work like our body. As our body consists of sensing organs same as smart cities consist of sensors and clouds. Sensor networks play a vital role in smart cities.

## III. APPLICATIONS OF SMART CITY

- 1) *Smart Planning:* Smart Planning helps to collect all the required data about the city like roads, hospitals, buildings, etc. [2] [8]. By using this information, a 3D map can be prepared to know the status of the city. Developers use this information to update the details through mobile apps [3][5].
- a) G Montenegro, N Kushalnagar proposed a 3D map of the city which collects all the data of the city like, energy, buildings, hospital etc which is saved in a database and used for updating the information to the people through mobile apps whenever it is needed [4].
- b) Iaria Greco and Angela Cresta proposed a "smart city" is generally meant as a technologically advanced city, capable of joining competitiveness and sustainability, by integrating different dimensions of development (economic, people, living, mobility, environment and governance) and helping in becoming self-sufficient [8].
- c) N. Walravens and P. Ballon, propose a platform model for implementation of the smart city [1].

2) Smart Parking



Fig 1: Smart Parking System [3]

Smart parking system plays an important role in the smart city ecosystem. Smart parking uses smartphones and other sensing devices to check the occupancy of parking slots or levels. It is connected to the cameras, counting utilities at the entrances or gates of parking structures, sensors embedded in the pavement of individual parking spaces.

- a) Y S Supreeth, S G Raghavendra Prasad, and Dr Jitendranath Mungara proposed a unique system wherein people living in the vicinity of crowded streets can rent their unused parking space. This approach enables productively managing the parking problem effectively during rush hours, especially in malls. Customers' time spent is reduced and they can find a vacant parking slot. This is achieved by using IoT which allows them to reserve a vacant slot in advance using pre-booking [9].
- b) T N Pham et al. proposed cloud-based smart-parking system. In this system user automatically find a free parking space which is cost effective. He proposed a system which uses WSN based on RFID technology to monitor car parks [19]. Driver are informed by notification on mobile that weather parking space is available or not.



Fig 2: Architecture of proposed system [19].

This system helps drivers to save time who are looking for parking slots. Driver log in to the system and choose suitable parking slots.

- 3) *Traffic Regulation:* One of the main challenges in a smart city is traffic congestion. Traffic regulation helps to reduce noise, greenhouse gas emissions and traffic congestion [10]. In this application, a map with traffic conditions of the city pushes in a mobile app that helps drivers to know the congestion on the roads, which way is short, and it also helps passengers to know which bus is crowded [3][4]. A sensor connected to the camera is installed in the bus for this purpose.
- 4) *Healthcare Management:* In IoT there are lot of devices are connected over the internet to recognize health issues.
  - a) Diane J Cook, Fellow, Glen Duncan et al proposed a system that makes healthcare to be more efficient.



Fig 3: Activity learning app collecting real-time data [11].

This software collects the information about the patient and processes the data using cloud services. Healthcare management's main motive is to monitor the patient's body without going to the hospital [11]. The blood pressure and heartbeat of a patient can be measured using sensors. It is also used in physiotherapy [3].

- b) Aditya Gaur et al. proposed a Multilevel Smart City architecture which is based on semantic web technologies and Dempster-Shafter uncertainty theory. He discussed some real time context aware on semantic web technologies and Dempster-Shafter uncertainty theory. He discussed some real time context aware solutions related to smart city architecture. The steps used in implementation of this architectures [14].
- **Collection of Data:** Sensors are used to gather the data in different forms like e-mail, database, messages, tweets. The collected data is heterogeneous in nature. So we need a common format of data which is the next step called processing.
  - **Data Processing:** The data or information collected needs to process and convert in the same format as Resource Description Framework (RDF) [12].
  - **Data Integration:** Here we need different technologies.
  - **Web Ontology Language (OWL):** It is used to relate data property and object property [12].
  - **Controlling of Device:** This step is used to offer messages, warning, or alert.
  - **Communication Services:** The required services are Wi-Fi, 3G, LTE, WiMAX, ZigBee, CATV and satellite communication [13].

Smart City Architecture

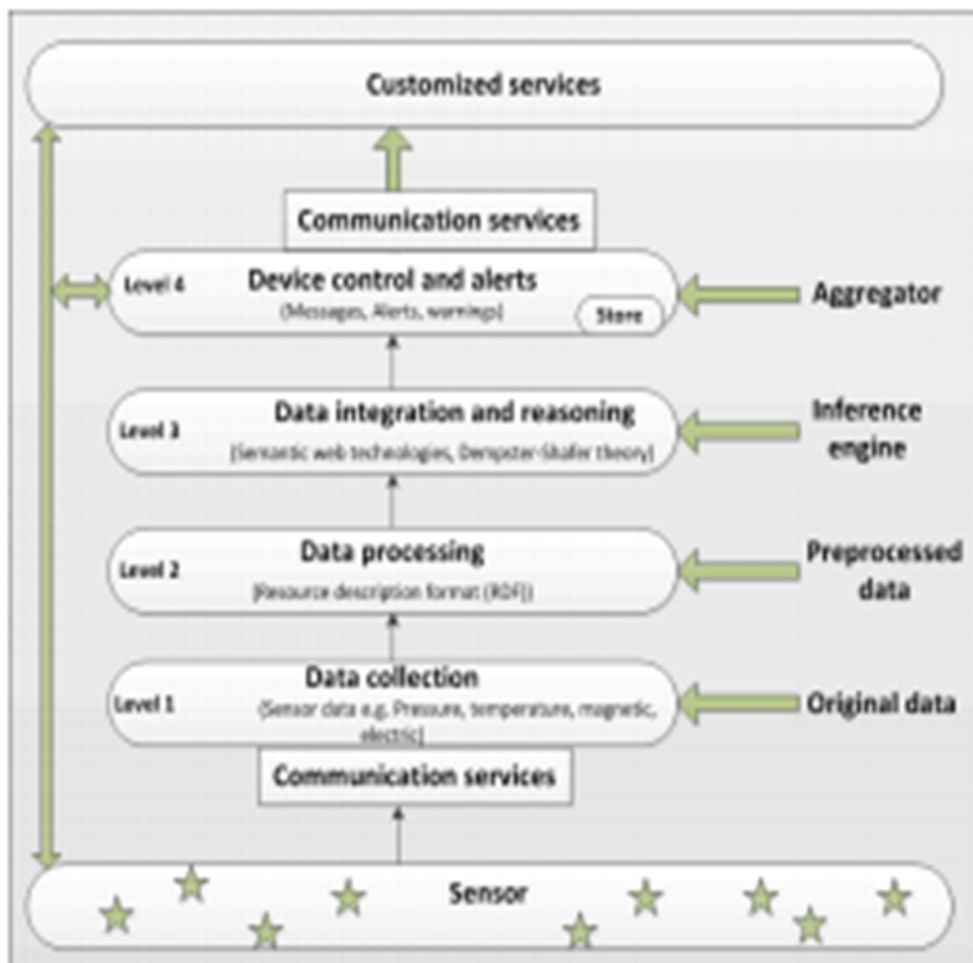


Fig 4: Multilevel Architecture [14].

The proposed architecture is designed for Alzheimer’s patients and elder people for their daily work. It sends alert and warning messages to end-users if the patient forgets and faces problems doing his daily activity. It is like a smart platform for people living in smart societies. The communication services required are Wi-Fi, 3G, LTE, WiMAX, Zigbee, CATV, and satellite communication [2] [14].



- 5) *Pollution Control*: Pollution is the main problem in the world. Pollution occurs when impurities mix with air, water, and soil. IoT setups provide a clear dashboard-based compact view of all necessary data to decision-makers.
  - a) Himadri Nath Saha proposed a system that gives information like PM levels in the air, moisture, humidity, pH of water is available at one place and this can be used in strategies to resolve air pollution and water pollution [12].
- 6) *Smart Estates*



Fig 5: Smart Estates [3].

In many cities solar panels spread over the buildings, in this case, we attach UV or solar sensors to the solar panels and trace the energy collection by plotting a graph on the computer, this if there is decreased or poor energy collection by any panel, we can able to notice that the panel is not working [3] and be replaced. In another case, if the panels extending to some extent are collecting the low energy it will be cloudy or rainy.

- 7) *Smart Building and Smart Home*: Smart buildings or homes are IoT enabled buildings that build on top of the existing facilities. These buildings are different from the old buildings. Smart buildings are equipped with various facilities [5][7]. These buildings are a combination of technology and modern infrastructure. These buildings are based on emergency lighting systems that work on system failure [1] [6].
  - a) Maninder Jeet Kaur and Piyush Maheshwari proposed a cloud computing model used for computing services that are accessible over the Internet. He proposes to use SlapOS (Simple Language for Accounting and Provisioning Operating System), an open-source Cloud Operating System which is inspired by Grid Computing and BonjourGrid [13].

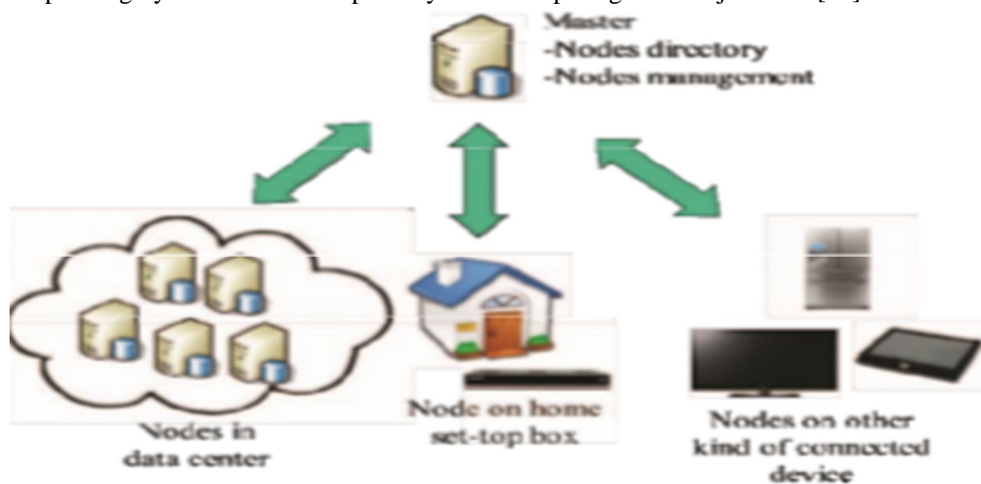


Fig 6: Slap over architecture [18].

This architecture is based on slave and master concepts as in fig. Slave nodes request master nodes to install the required software. Master nodes work as a web portal so that users request software and run on slave nodes[13][18].

- b) J Pourqasem proposed cloud based smart home system [16]. Here sensors measure the temperature and humidity of home with the help of Arduino based IoT devices. The cloud-based applications improved the efficiency of IoT devices. He proposed integration of cloud and IoT based infrastructure. But the main problem in this infrastructure is heterogeneity of various components and technologies, which affect the data processing and transmission. Some major problems\_of technologies are mentioned in next section. Cloud-Based IoT: Integration Cloud Computing with the Internet of Things.

#### IV. CHALLENGES AND RECOMMENDATION

There are some challenges in creating smart cities as below.

- 1) *Infrastructure Funding*: Smart Several devices and technologies integrated together in smart city deployment. These devices are used to collect the data in real time. The installation and maintenance of these devices requires a huge amount of money, therefore arranging funds for the development is a huge task.
- 2) *Safety and Privacy*: One of the major issues using IoT is safety. Data hacking is the biggest problem for the citizens. Different companies are using different ways and technologies to ensure data safety. Privacy of citizens should not be hamper by anyone [17].
- 3) *Connectivity Between Devices*: There are a lot of smart devices connected for collecting the real time data for an efficient city management system. So, there should be high speed internet connectivity for efficient communication between devices. 4G coverage is not enough for data transmission between these devices. So, we need faster communication technology [17].
- 4) *Funding Issue*: Smart Several devices and technologies integrated together in smart city deployment. These devices are used to collect the data in real time the installation and maintenance of these devices required a huge amount of funds. To arrange the fund for smart cities is a difficult task [15].

#### V. FUTURE SCOPE

We require future smart cities with more secure applications. Technology adapted should be more flexible to meet the future requirements. Data is a core of smart city concept. A smart architecture can control, compute and communicate on the basis of data collected by sensors. Smart infrastructure leads to various advantages like more effective and flexible services. But there are many problems in implementing smart city concepts like safety and other issues. By removing these hurdles, we can establish a desirable and reliable smart city.

#### VI. CONCLUSION

The paper depicts the different applications used in developing smart cities using IoT. These applications merge wireless sensor networks and computer networks. Smart Applications in industry, houses, hospitals, transport, buildings are covered which are required for an efficient and comfortable life in the modern era. The Internet of things is the main concept used in each application. Its importance in transport is also discussed and how it saves many lives. Paper discusses environment - friendly applications like pollution control IoT application, which can make the city and the people clean and healthy.

#### VII. ACKNOWLEDGEMENT

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